

UNLOCKING NEW SATCOM MARKETS AND CAPABILITIES with Next-Gen Ground Segment

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and ST Engineering iDirect.

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Introduction

To say that the satellite industry is going through a profound transformation is an understatement. Satellite capacity is growing by orders of magnitude. New and previously unconceivable markets are being addressed. Global mega-constellations are in the plans to be launched. Customer requirements are increasingly sophisticated. All of these challenges and opportunities will not be met without major steps forward in ground segment platforms.

The space segment has attracted most of the innovative focus in recent years. And the industry is targeting a wide spectrum of new applications to reactivate growth. Ground platforms must provide the tools to manage skyrocketing throughputs, as well as the expanding number of terminals.

New verticals have very stringent requirements from a ground segment point of view. Supporting a cellular backhaul link presents many challenges, such as escalating throughputs, traffic manipulation, or bandwidth sharing. Similarly, mobility has particular requirements like beam switching, global coverage, and interference mitigation.

Furthermore, business models are evolving rapidly towards managed services, such that VSAT platforms must offer a robust virtualized network management system allowing the flexibility to host multiple networks with diverse competencies.

The future of the satcom industry is quite exciting with a multitude of innovative ideas about to hit the marketplace. But none of these new technologies will materialize without a powerful partner on the ground.

ST Engineering iDirect Market Position

ST Engineering iDirect is the leading enterprise TDMA satellite communication provider. Our satellite platform sets the standard in performance and efficiency, and enables our business partners to deliver high-quality voice, video and data connectivity anywhere in the world. Over the course of 20+ years, the platform has become the most trusted platform and the leading market share holder across mobility, enterprise and government markets.

Our platform consists of a highly flexible, Evolution/ Velocity hub, a versatile series of high performance remotes, with fully integrated management system, to form a unified IP-based satellite communications architecture. This enables satellite providers to deliver the right throughput rate at the right cost, run large networks cost-effectively, deploy new services rapidly and continually stay ahead of the pace of technology.

With partnerships ranging from Inmarsat GX, IntelsatOne Flex and SES Skala Networks in both the fixed and mobility segments, we continue to be a leading actor in the VSAT platform ecosystem.



Enterprise VSAT

The enterprise VSAT segment has historically provided very meaningful opportunities for the satellite industry with millions of in-service units around the globe. However, this segment has seen challenges for the last two to three years. Some of the traditional drivers for growth suffered from saturation, macroeconomic pressures, price degradation or the expansion of ground alternatives.

In this difficult scenario, 2016 started to show some signs of recovery. Competitively priced capacity, together with advanced ground equipment and improved macroeconomic prospects, triggered growth in key applications.

High Throughput Satellites (HTS) Reactivating Growth After Several Years in the Doldrums

The arrival of HTS is unlocking new markets for satcom. The radical decline in capacity pricing is attracting demand for data-hungry applications. Interestingly, higher power beams are also allowing the utilization of lower-cost terminals, opening new markets in the low-end segment.

Data requirements are booming, which translates into a move towards premium products on ground terminals. Satellite operators, which are now incorporating the management of the ground segment, see those applications as critical for growing their capacity revenues. Connectivity is commoditizing, and ground equipment must be a facilitator for value-added services and network efficiencies.

Demand on traditional widebeam satellites will fade away steadily as most of the demand progressively transitions to HTS architectures. Ground platforms will need to adapt to the complexities of HTS, while being flexible enough to offer customizable services at the application layer.

Key Applications Driving Growth

Despite the recent declines in the market, there are several applications on the horizon that generate attractive opportunities for the satellite industry.

Social inclusion will see spectacular growth. In Latin America, some programs seem to have taken a momentary pause; but rollouts will continue with better economic prospects and newly available HTS capacity. Asia has the potential to host massive deployments in countries like India, Indonesia, or Malaysia, among others. Similarly, in Africa, multiple countries have kick-started digital divide programs. Even developed markets are showing strong prospects for digital divide initiatives.

Massive declines in oil prices slowed demand in the energy markets; however, investment in the vertical seems to be flowing once again. Furthermore, the general trend towards automation and efficiencies will only accelerate the need for connectivity.

Government/military markets are recovering, considering a rise in demand. From law enforcement and post offices in Latin America, military applications in North America, or embassies in Africa—opportunities are abundant across the globe.

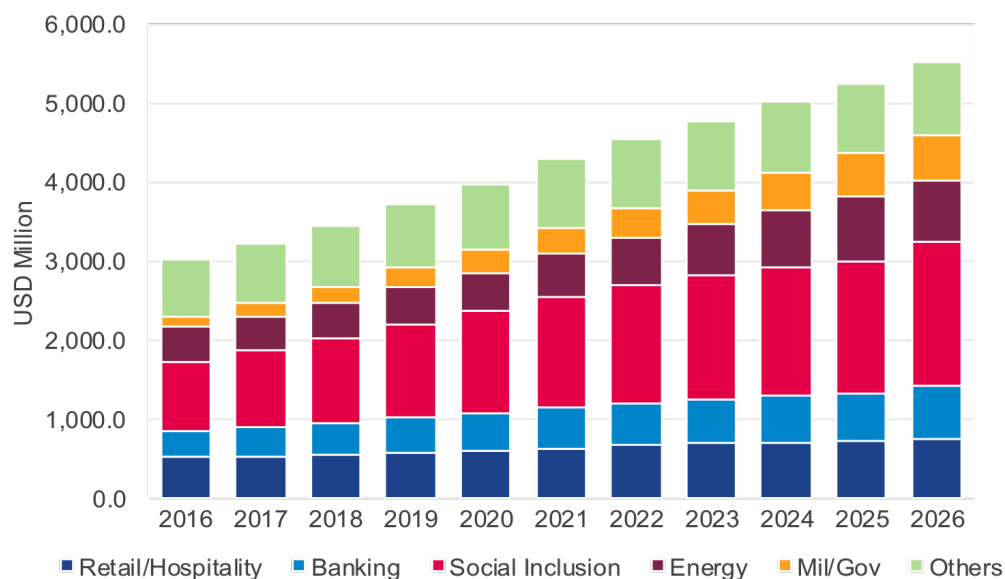
With capacity and terminal prices becoming more affordable, satellite is expanding its footprint in the small business/SOHO/retail segments. Internet connectivity is now a basic need for any business, and these services still see strong demand in areas like the Middle East and Africa.

Case Study

Assume a gas station generating \$40,000 in revenues per month; with an online point of sale system and a ground network availability of 95 percent. If satellite could boost that reliability by just 3 percent, with a monthly cost of approximately \$40, the satellite link would be able to generate \$1,200 in additional revenues.

Satellite can still offer a solid value proposition for the retail market, even when ground alternatives exist. Furthermore, many of these gas stations are increasingly adopting more data services such as gas conditions monitoring, video security, guest Wi-Fi and others — boosting bandwidth requirements.

Fixed VSAT Service Revenues by Application



Source: NSR

Beyond the high-data-traffic applications, HTS also opens the lower-end space. The banking segment still has tremendous room for growth. Asia continues to be a very solid market with India, Indonesia, Malaysia, and other countries in the region still deploying thousands of ATMs on satellite every year. Africa has good opportunities for end-to-end branch connectivity, and with half of the population in Latin America still underserved by formal financial services, the opportunity in the region is clear. Despite the absence of massive deployments of Internet of Things (IoT) projects in FSS bands, multiple players are testing the waters and could become a massive growth opportunity in the medium to long term.

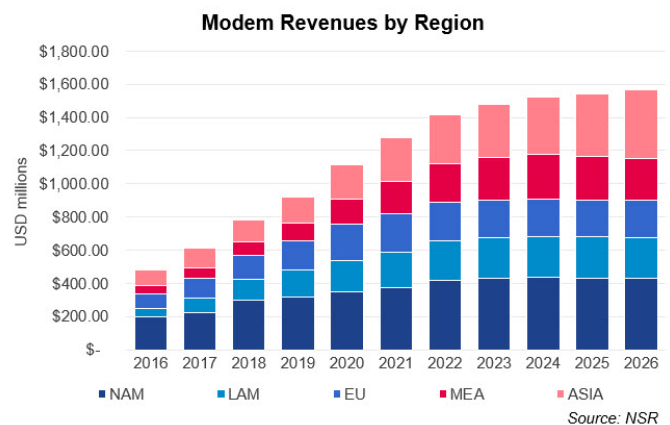
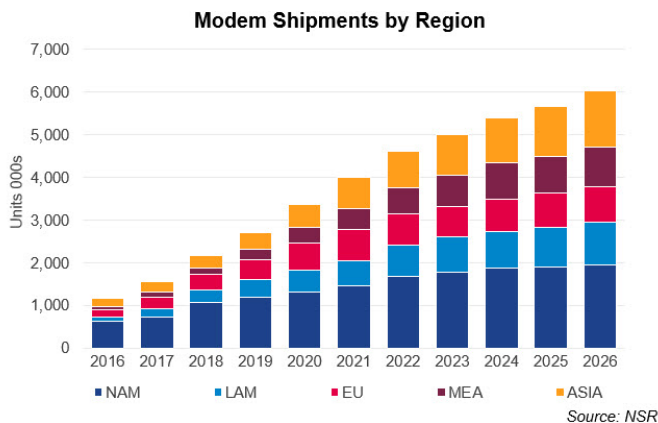
The Opportunity for Modem Vendors

Relatively hype-free, and generally not characterized with the explosive developments of other verticals; fixed enterprise VSAT remains a solid market with attractive growth prospects. This segment will generate the highest cumulative revenues of any other professional vertical for modem vendors. In the next 6 years, terminal shipments will grow at a 7 percent CAGR, expanding annual modem

revenues to close to \$320 million by 2026 and generating \$2.8 billion in cumulative revenues.

Developed economies show the slowest growth opportunities. Strong competition from ground alternatives and market saturation limit growth; however, the return to growth for energy and government/military together, along with emerging verticals like IoT, will present positive prospects.

Emerging markets host the most attractive opportunities. Asia will be the fastest-growing region driven by the traditional Indian, Indonesian, and Malaysian market, together with a number of countries with increased appetite for satcom like Myanmar, the Philippines, and Pakistan. MEA has a huge addressable market, but underdeveloped distribution channels hinder short-term growth. Key verticals for growth in Latin America have historically been slow to develop due to various factors constraining short term evolution, however, better economic prospects together with competitively priced capacity are putting the region back on the growth track.



ST Engineering iDirect Market Share

Our platform is the leading Enterprise TDMA market offering and is widely accepted and deployed to support a variety of applications and services. Its market position is particularly strong in Africa, Europe, and the Americas, while it is improving its footprint in Asia by engaging with additional operators and service providers in the region.

For Social inclusion, the platform powers the largest distance-learning program in Brazil, in partnership with Via Direta, and also offers distance learning with Elara Comunicaciones in Mexico with its 10K program. In Energy and Utilities, we are considered the de facto solution with its close relationships with leading service providers like Rignet, Speedcast and Globecom. In Banking, thousands of sites have been deployed in partnership with Q-KON across Africa.

We are also the platform of choice for many large telco's like Verizon, British Telecom and Orange Business Services. Whether they use VSAT for large-scale retail outlets or backup disaster recovery, satellite has played a critical role in delivering enterprise solutions to offer their customers seamless connectivity.

Setting the standard in flexibility, performance and efficiency, the platform consists of a universal hub and a versatile series of high-performance remotes with a fully integrated management system. Together, these form a unified IP-based satellite communications architecture and enable service providers to serve multiple markets, and support different business models and SLAs from a single platform while realizing the lowest cost of ownership.

Furthermore, we have adapted well in the transition to HTS-managed services, becoming the key platform for a variety of satellite operators such as Inmarsat, Telenor, Intelsat, SES and Yahsat.

Today, the satellite industry is migrating toward the DVB-S2X satellite transmission standard to realize greater performance and efficiencies. By adopting the DVB-S2X standard, service providers can leverage the availability of HTS in their markets to deliver greater performance and efficiency. Our DVB-S2X product suite offers DVB-S2X on the Universal Line Cards (ULCs), our iQ Series as well as higher hub density and processing capabilities through virtualized hub components.

We have taken the lead in redesigning the foundation of our satellite remote. The iQ Series is built around the latest DVB-S2X standard. It leverages a software-defined architecture that can be continually upgraded over-the-air to increase network capabilities and throughput levels. This gives service providers a new degree of flexibility to meet requirements, while dramatically extending its deployment life. The iQ Desktop has been adopted by leading providers like Bentley Walker, Datagroup, DOZOR-TELEPORT and Liquid Telecom to offer Enterprise services throughout Europe, MEA, Ukraine and Africa with a new performance and cost model.

We are the leading vendor in terms of market share for fixed VSAT modem revenues, accounting for 22 percent of shipments and 23 percent of modem revenues. The company continues to innovate and respond to the most pressing requirements of the industry and, thus, we are at the forefront of growth markets, ensuring its long-term leadership position within the industry.



The aeronautical connectivity market is driving explosive growth for the satellite industry, and ground segment is one of the most critical elements in the equation. From global baseband deployments, operating in a harsh environment, to skyrocketing throughputs, VSAT platforms need to support complex requirements.

With global penetration among airliners and business jets still nascent, and travelers' expectations continuously rising, this vertical will see explosive growth in the coming years.

Case Study

Assume a narrow-body aircraft transporting 15,000 passengers per month. If 10 percent of those passengers contract a \$10 connectivity service, and considering a monthly cost per airframe of \$7,000, the airline would be able to generate an extra \$8,000 per month per aircraft of ancillary revenue.

Low-Volume, High-Value Market

In the coming five years, the aeronautical satcom market will experience skyrocketing growth as more airlines and business jets incorporate satellite connectivity, generating attractive revenues for all steps of the value chain.

Airborne connectivity is driven by the passengers using their personal electronic devices onboard aircraft and, to a lesser extent, operational requirements such as maintenance, crew communications and safety applications. This is further driven by capacity prices that have come down considerably while the available bandwidth per aircraft has grown substantially to feed more end-user applications.

Airlines see satcom connectivity as a 'must-have' and will seek to serve more passengers with IFC to address pent-up passenger demand.

Furthermore, recent aircraft demand forecasts by Boeing, Airbus, Embraer, and Bombardier have all been modified to higher figures over the next 20 years. As such, the commercial passenger addressable IFC market represents roughly 23,400 aircraft in 2016, and is set to grow by more than 10,000 in the next decade, driven by strong growth in Asia, where almost 25 percent of the overall market will come from.

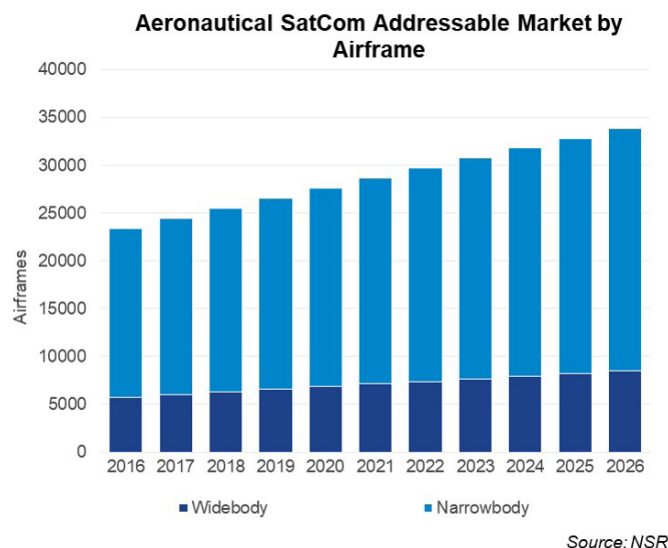
Given the size of the addressable market, the aero vertical remains a moderate opportunity in terms of shipments for equipment vendors, but those shipments will be comprised of highly sophisticated elements, creating a premium revenue opportunity.

Competition in the aeronautical market is heating up with an increasing number of actors trying to enter the vertical. While prices in the value chain are under the most pressure in the aero market, building strong partnerships is crucial to ensure the long-term technological leadership necessary for market success.

High-Flying Complexities

Terminals in the aeronautical market work under one of the most difficult environments. Antennas carry very sophisticated requirements in terms of form factors (aerodynamic limitations), weight, pointing accuracy, reliability and many other technical requirements. Similarly, RF equipment has strong limitations in size and weight, while skyrocketing throughputs continuously demand more power. Modems orchestrate the link offering high-quality, high-speed communications in this challenging ecosystem.

Modems and baseband equipment operating in this vertical have very sophisticated requirements. The global nature of demand involves high initial CAPEX investments in baseband equipment. Routes and traffic patterns change depending on the season, and anytime of the day, which



requires very flexible networks. Consequently, requirements for the network management system are very sophisticated and include ensuring advanced Service Level Agreements for individual aircrafts and fleets running applications at different priority levels with planes constantly migrating to different beams and satellites — all this with end-users enjoying the highest standards of connectivity.

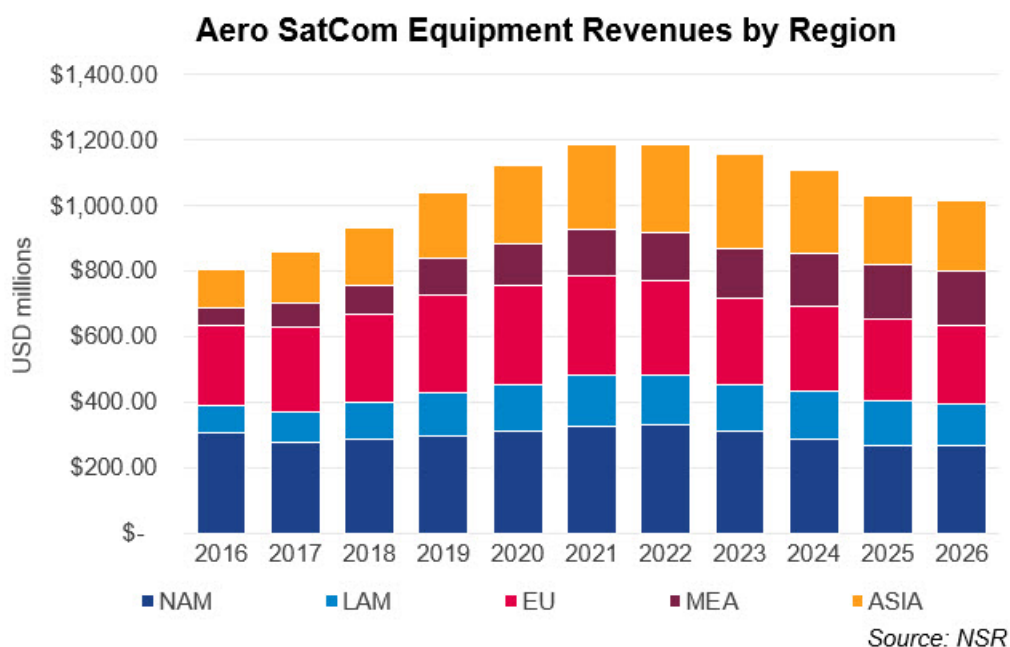
Ultimately, beam hopping and beam forming are capabilities that ground platforms and the space segment need to coordinate to optimally utilize capacity. Equipment must serve all these requirements, while meeting the stringent, expensive, and exhaustive certification process involved for any equipment used in the aeronautical sector.

The Opportunity for Modem Vendors

The aero revenues for modems will almost double by 2021 driven by rapid growth in the installed base. One must also note that the opportunity on the baseband side is likewise tremendous, given the complexities of mobility networks (see more details in the Baseband section).

Commercial aviation generates the largest portion of revenues, continuing to grow rapidly during the next five years. Then, after an intense installation period, the demand will stabilize. After 2021, shipments in the commercial aviation segment will be primarily retrofits and upgrades, as newer installs will occur when there is a strong case for a technology refresh.

On the other hand, the business aviation market is mostly untapped and shipments will steadily grow beyond 2026. However, the small size of this segment will not compensate for the slowdown in commercial aviation.



ST Engineering iDirect Market Share

With more than 20 years of experience in the mobility field, we are the vendor of choice for providing aeronautical VSAT services. Today's in-flight connectivity challenge is about meeting rising customer expectations while allocating a broader pool of bandwidth to feed connected aircraft applications. Combining HTS with mobility applications presents a major challenge for providers when it comes to managing complex Service Level Agreements. The increased capacity available through HTS will mean very little unless you can increase the quality of the end-user experience. Due to this, it is becoming increasingly difficult to manage bandwidth across a contended network that spans multiple beams, aircraft and end users.

At any given moment, there are thousands of aircraft operating around the globe, with each one needing to connect to various bandwidth levels over the course of a journey. Even with faster modem speeds, bottlenecks can occur if network traffic is not prioritized correctly. Those operating aero VSAT networks need to expand their thinking from what data rate is being delivered on an individual airplane to how do they source, integrate and manage a global pool of bandwidth.

Our platform is designed to handle these unique high-speed mobility applications. The platform features high-performance VSAT router boards designed for special integration onboard the aircraft and is further distinguished by a comprehensive range of advanced mobility technologies.

Today, we are powering the networks of leading operators in the segment, such as Inmarsat's Global Xpress Network, Panasonic, GoGo and SES, with more than 1000+ planes flying and hundreds in backlog. We are the leading modem equipment vendor in the aeronautical satcom market, with 53 percent of commercial aircrafts with installed modems onboard.





Maritime Satcom

Satellite has served the maritime communications market for decades but VSAT penetration remains modest. However, this is changing rapidly. From Internet of Things (IoT) and big data in the offshore segment, to sharing selfies onboard a cruise ship and supporting crew welfare on a merchant vessel, data traffic is growing exponentially. As a result, VSAT acceptance is accelerating.

The combination of desire for larger data pipes with competitively priced capacity and advanced ground segment creates the perfect conditions for the market to flourish. VSAT is making strong inroads in segments that still show massive growth potential.

Time for VSAT Broadband Adoption

Transition to broadband connections will only accelerate in the next 7 years, and no segment in the maritime ecosystem will resist this trend. From merchant shipping to leisure and passenger vessels, VSATs will increase their penetration to reach almost 50 percent of all broadband links by 2026.

This growth obviously entails new challenges for modem vendors. Remote units need to support 100s of Mbps, while incorporating new sophisticated features, such as beam hopping, beam forming, flexible bandwidth allocation and traffic optimization tools, all in a globalized network ecosystem.

Diverse Set of Needs

Within the maritime market, there is a wide variety of customers with differentiated requirements, but a common denominator of increased reliance on data services.

The offshore segment is already highly saturated and facing macroeconomic headwinds, but the transition to HTS opens some near-term opportunities for the satellite industry, especially for the highly specialized players. The maritime market features some of the most demanding customers in terms of throughput levels, reliability requirements and network sophistication.

The fishing segment offers the largest addressable market of any segment. Yet penetration of broadband services in the segment is insignificant at just 2 percent. Most of the time, regulations are the main driver and higher-value products are difficult to monetize. The evolution of terminals, including antenna form factors and price offers, could potentially unlock the market, especially the higher-value fishing fleets.

Similarly, the leisure market presents another massive addressable market; however, penetration is low primarily because of limitations such as form factors and affordability. Flat panel antennas have the potential to unlock new portions of this market.

With significant room for growth for broadband adoption, passenger ships offer a strong case for satellite connectivity, where the arrival of HTS is opening the lower-end ferry market. It is worth noting that peak consumption for passenger vessels can be explosive.

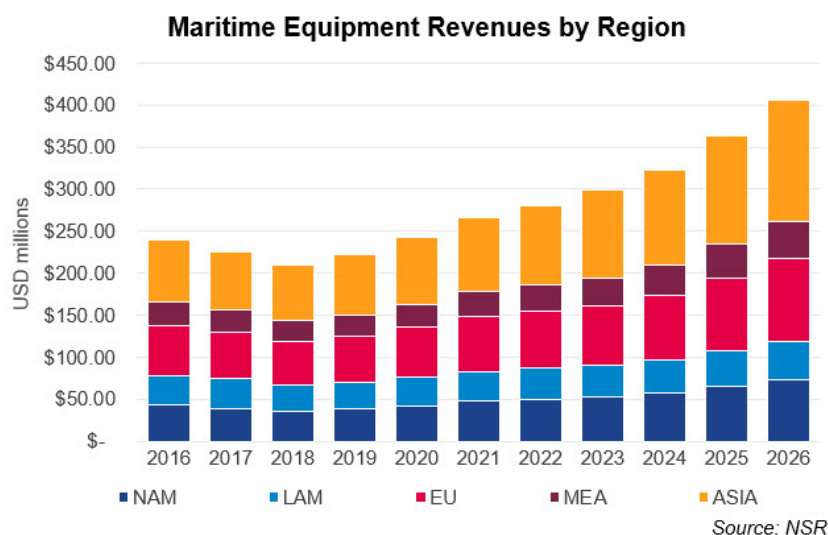
Merchant shipping will develop as the fastest growing market for equipment revenues with a rapid migration towards VSAT services. From crew welfare to en-route information, asset monitoring, or the number of applications the link must be able to support will be high.

Case Study

Assume a merchant shipping vessel consumes around \$10 million of bunker fuel per year. If en-route information such as weather updates and engines telemetry could save 1 percent of that cost and, considering a \$4,000 monthly connectivity price, the shipping company could save 2x that cost on connectivity.

The Opportunity for Modem Vendors

As VSATs gain market share in the maritime satcom market, modems will experience healthy growth over the next 10 years. The biggest portion of this growth comes from the lower-end segments of the market, explaining why revenues grow at lower rates as compared to shipments. FSS/HTS modem sales will top \$12 million in annual revenues by 2026.



ST Engineering iDirect Market Share

We are considered the de facto standard in the vertical with nine of the top 10 satellite service providers in the maritime ecosystem by revenue relying on its platform.

Our diverse range of terminals spans across the entire maritime market, covering segments as varied as superyachts, cruise ships, merchant shipping and oil & gas. With the introduction of the iQ 200 Series remote for the maritime market, partners like Marlink and Speedcast are seeing tremendous growth.

In addition, leading satellite operators such as Inmarsat, Intelsat, SES and Telenor, chose us as their ground segment partner to power their managed network offering. This selection is based on the critical technological advantages offered by ST Engineering iDirect, including advanced mobility features like beam switching and a robust Network Management System.

ST Engineering iDirect is the leading modem vendor in the maritime market capturing 48 percent of the modems installed in 2016.



Cellular Backhaul

Satcom has historically captured opportunities in cellular backhaul. However, these opportunities were restrained to very remote locations, generally driven by government incentive programs. Satellite was perceived as a slow, expensive and cumbersome solution, only able to capture 1.3 percent of global base stations (2016 Satellite Market Share by BTS Backhaul Technology).

Combining the rapid drop in space segment prices with sophisticated and highly capable ground equipment, the picture is changing radically. Today, satellite is attracting large deployments across the globe and is considered a very flexible and capable solution in the backhaul technologies mix.

Satellite Enabling Mobile Network Operator (MNO) Revenue Growth

The bulk of the demand for satellite backhaul services in number of sites is still derived from legacy 2G stations. But, 2016 marked a major inflection point and for the first time 3G generated the highest level of capacity demand.

With new satellite backhaul economics, mobile operators no longer consider satellite a low bandwidth solution, and now regularly implement broadband services over satellite. Peak capacity consumption for 4G sites can climb as high as 100 Mbps, a clear indication that broadband demand is taking off. By 2026, NSR estimates that less than 10 percent of satellite active sites will still serve 2G networks. The remaining sites being comprised mainly of 4G stations.

Global mobile operator revenue growth has slowed down. Subscribers have reached saturation in many areas and MNOs rely on data services for revenue growth. Helping mobile operators extend these services to remote locations, and ensuring the quality of the link, are key opportunities for satcom. At the same time, risk aversion among MNOs is growing, thus a solution requiring low CAPEX is highly attractive, despite incurring higher OPEX later in the business cycle.

All in all, new use cases are opening for satellite backhaul. From offloading traffic in congested areas, postponing or avoiding ground network upgrades to sporadic use cases like highways, railroads or sporting events; even first-responder networks requiring ubiquitous and reliable coverage are becoming profitable applications for the satellite industry.

Pricing Elasticity in Cellular Backhaul

Decreasing the Total Cost of Ownership for satellite backhaul has an immediate and significant effect on the demand the industry can attract. If the cost of satellite capacity declines, the crossover point where microwave is more cost effective than satellite moves towards higher traffic. Conversely, if capacity becomes cheaper, satellite can compete against microwave in higher-traffic sites.

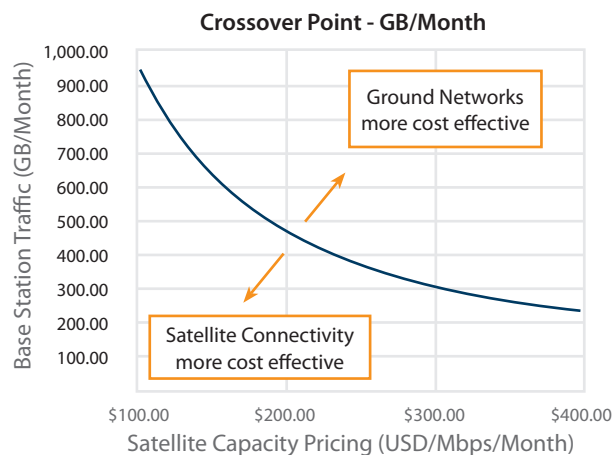
Mobile data traffic is highly concentrated in the denser segments of the network. According to Nokia, just 15 percent of base stations carry 50 percent of the traffic. This explains the long tail of stations carrying small levels of traffic. A slight increase in the crossover traffic, at which satellite is more cost efficient than microwave, will rapidly translate into higher levels of demand for the satellite industry.

Combining the low CAPEX setup cost of satellite with the currently highly competitive capacity pricing, satellite backhaul is becoming a very attractive solution for sites requiring high speed, but low data volumes.

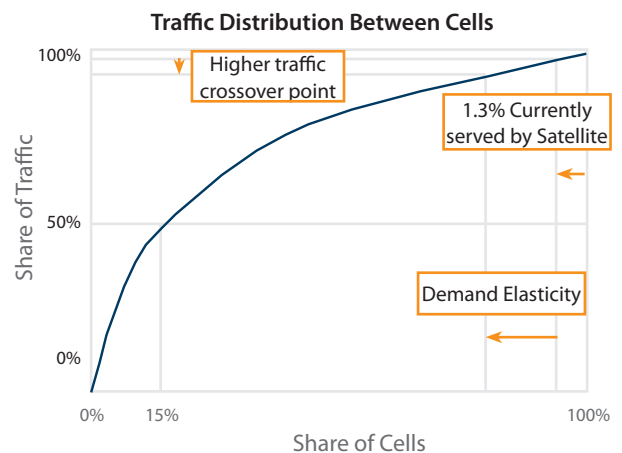
Case Study

Assume 1,000 subs per Base Station consuming 0.3 GB/month/user (Sub-Saharan Africa average). This leads to a traffic consumption per BTS of 300 GB/month.

If satellite capacity costs below 300 USD/Mbps/Month, Satellite Backhaul would be more cost effective than any ground alternative.



Source: NSR



Source: Nokia & NSR

Ground Platforms - Key Market Enablers

Ground equipment plays a paramount role in unlocking growth in the satellite backhaul market. As demand transitions to 3G and 4G, modems require high levels of sophistication to support new requirements.

In order to qualify for 4G deployments, a typical requirement from MNOs is that modem throughput must surpass 100 Mbps to ensure the site is future proof, even if today's actual implementation goes below 50 Mbps. Given the new traffic patterns (peaky traffic), bandwidth pooling and statistical multiplexing are key features for boosting capacity utilization. Needless to say, with these huge pipes, spectral efficiency (Mbps/MHz) is critical and rapidly translates into major OPEX savings.

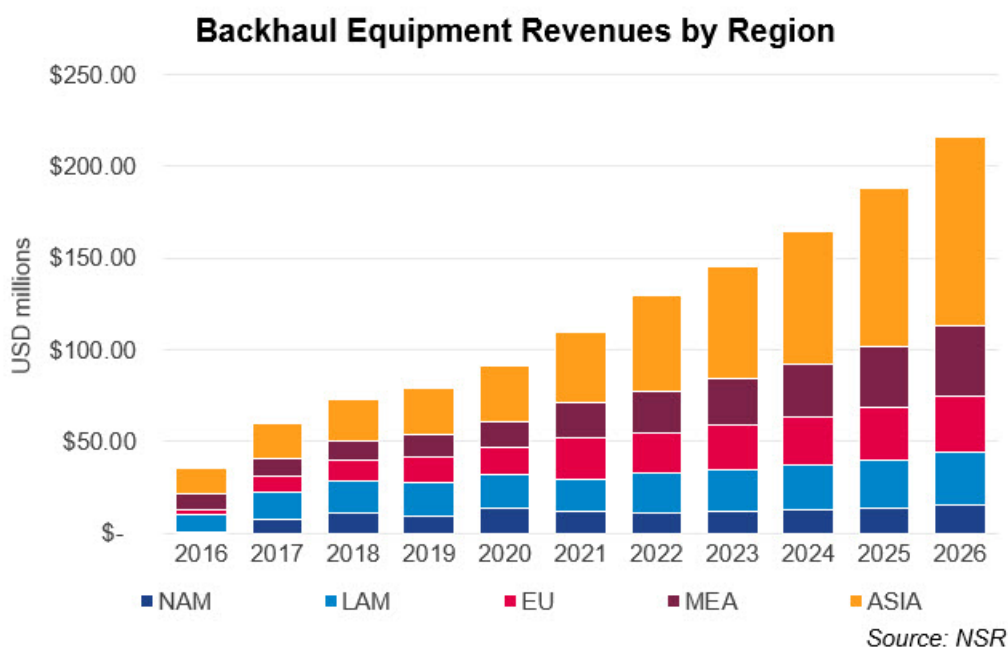
Furthermore, mobile networks pose very stringent requirements for higher layers of communications that satellite terminals need to solve. Minimizing the traffic that actually needs to go through the satellite link is another major feature of the most advanced terminals. Data compression, optimization, local cache, etc. are typical attributes of the new generation terminals. Mobile protocols are sometimes not very well suited for satellite backhaul and traffic acceleration and protocol trimming are key functions for advanced modems.

The Opportunity for Modem Vendors

The satellite backhaul vertical is poised to become one of the key revenue generators for equipment vendors. With a continually expanding install base, cellular backhaul will move from being a niche application to generating over 204,000 high-value terminal shipments in the next 10 years. The transition to 4G also triggers a move towards higher-end modems, driving revenue growth at 15.2 percent and rapidly translating into higher levels of demand for the satellite industry.

Developing markets continue to be a strong source of demand for satellite backhaul. Declining cost of mobile phones, a drive to extend network coverage, adding new subscribers, coupled with government support and obligations, provide big opportunities for satellite backhaul in emerging economies.

With the new use cases, large deployments are also appearing in developed economies. The need to provide ubiquitous coverage (sometimes driven by land area rather than by population coverage) and the requirements for very high levels of availability have opened opportunities for satellite backhaul in developed markets.



ST Engineering iDirect Market Share

Our highly differentiated Real Time Traffic Management (RTTM) feature set and award-winning bandwidth allocation algorithm, Group Quality of Service (GQoS), are an inherent part of our platform. We have evolved our product offering to adapt to the new requirements for cellular backhaul with Layer 2 over Satellite (L2oS), which transparently passes Layer 3 traffic, allowing the satellite network to behave like a mainstream access network. Our iQ 200 with SatHaul-XE solution combines our long-standing leadership in hardware technologies with a new set of advanced optimization capabilities to meet MNOs' most challenging requirements.

With the SatHaul solution and in partnership with Speedcast, one of the most successful service providers in this vertical, we demonstrated GTP/LTE traffic transmissions at speeds over 350 Mbps on the downstream and 90 Mbps on the upstream — meeting and even exceeding the typical requirements from cellular operators.

MOTIV, a leading mobile operator in Russia, decided to upgrade its 2G network, already running on our platform, to offer 4G/LTE services leveraging the SatHaul solution combining our remote and our L2oS technology. Telespazio Argentina deployed our cellular backhaul solution adding thousands of new subscribers, providing a new line of revenue in an otherwise saturated mobile service market.

ST Engineering iDirect is one of the top three modem vendors in the satellite backhaul market, driving 13 percent of modem shipments and generating 6 percent of modem revenues.



Baseband Equipment

As the brains of the VSAT network, baseband equipment is at the core of all the developments in the networking space. The developments in ground segment need to be in sync with the pace of innovation in the space segment. This means scaling to larger High Throughput Systems (HTS), adapting to the new nature of traffic and adopting the latest strategies in network architectures, all while managing the challenge of cost control.

More and Smarter Bits per Hertz

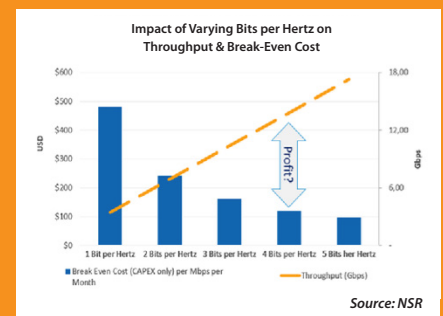
No one can deny the global trend of capacity pricing degradation. This scenario sets pressure on ground platforms to continually improve the bits per Hertz figure of merit. Thus, satellite operators can offer more competitive pricing based on Mbps, while keeping prices per MHz more stable.

All major platforms have incorporated the DVB-S2X standard, achieving impressive bandwidth efficiencies. But there is still room for further improvements, especially in aspects such as the return channel, higher signal strength links applicable to HTS and minimizing interference, which are future key challenges-especially with Low Earth Orbit (LEO) satellites.

With DVB-S2X approaching the physical limits of bandwidth efficiency, the focus now shifts towards higher layers of communications. Traffic manipulations can reduce traffic volumes by a significant margin, effectively improving Quality of Service (QoS) while minimizing costs. Header trimming, data compression or even integrating cache servers, are all strategies increasingly important for VSAT platforms.

Case Study

Assume a \$300 million satellite, with 96x36 MHz TPEs, 15-year life cycle. Bandwidth efficiencies (Mbps/MHz) have a great impact on the capacity pricing to break-even CAPEX costs. Ground segment is playing a bigger role in a satellite operator's ROI.



Scaling to (Very) VHTS

Skyrocketing capacity poses a whole new set of technical requirements for baseband equipment. Gone are the days of a fixed 36-MHz transponder. Today's systems go to 500 MHz, and in the future, this could rise to several GHz. With the increasing number of beams, baseband equipment needs to manage a larger number of carriers and consequently, larger throughputs that support a larger number of terminals.

CAPEX investments in ground equipment are becoming very large. With satellite throughputs continuously expanding, baseband costs cannot scale with performance to keep investment in the ground segment at reasonable levels. Additionally, baseband platforms must be scalable to pace these CAPEX investments as networks start with a small number of terminals, but expand continuously with new customers being added over time.

In this current ecosystem of highly contested and rapidly evolving markets. It's different to generate business in a single vertical, especially in larger HTS systems. Any platform bidding for big HTS projects must be able to support a wide array of applications.

Having said that, one must not underestimate the opportunities in smaller networks. Some customers still own specific requirements for in-country traffic landing, private networks or a special need for traffic security, which continue to generate opportunities for smaller hubs.

Boosting Space Assets Utilization

Ground segment has a key role to play in optimizing the utilization of space assets. Many of the new applications driving growth (Consumer Broadband, Cellular Backhaul, and Mobility) are witnessing an important change in traffic patterns where consumption is becoming 'bursty'. Flexible bandwidth allocation and statistical multiplexing are essential to minimize aggregated capacity consumption.

HTS requires a much higher investment in the ground segment, and satellite operators are incurring those investments to facilitate the lease of capacity to service providers. In this Mbps ecosystem, satellite operators have greater visibility over the traffic in the network. This enhanced visibility can be leveraged to monitor consumer behavior and eventually generate actionable insights to intelligently use the available resources. Network Management Systems (NMS) are consequently becoming more critical to ensure QoS, while optimizing resource utilization in an ecosystem with very diverse Service Level Agreements (SLAs).

New features on satellites are closely interconnected with ground segment like beam hopping, beam forming, or gateway redundancy. All these features need to be integrated in today's platforms. Network Cloudification, Software Defined Networks, and Network Function Virtualization offer great potential for the satellite industry.

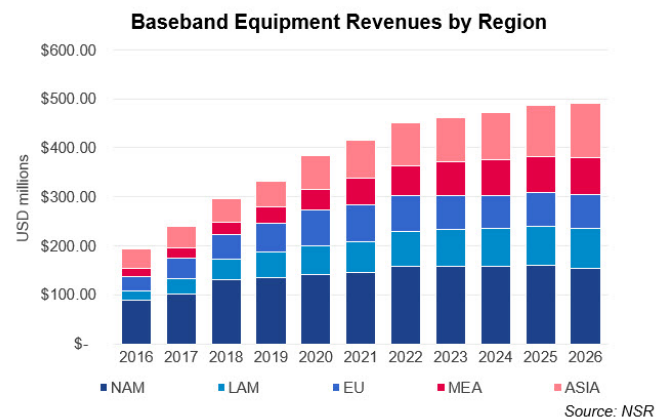
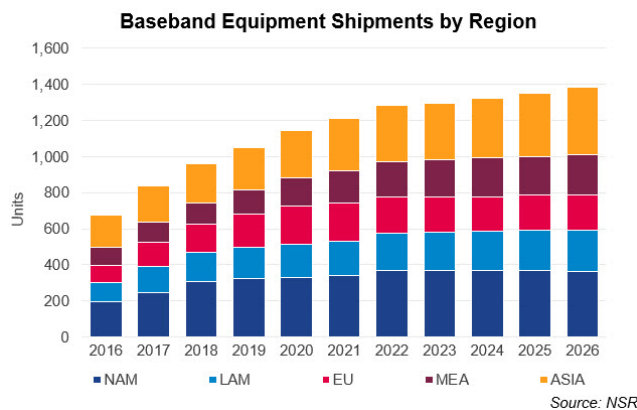
The Opportunity for Equipment Vendors

The boom in HTS deployments is driving the highest opportunities for baseband equipment demand. Despite many deployments procured to support specific target markets, platforms must operate in a multi-application environment, able to concurrently serve other use cases.

Some networks, such as mobility, generate a comparatively big opportunity despite the limited number of modem shipments. The complexities of these networks in terms of coverage, roaming or beam hopping are driving very large deployments recently.

On the other hand, legacy markets will still provide a meaningful opportunity, but evolution will be much slower. Some networks for back-up services, content sharing and special coverage requirements will continue to operate on widebeam satellites; however, demand will migrate to HTS systems over time.

Regionally speaking, emerging economies are growing at a faster pace, but developed markets present larger cumulative opportunities over the next 7 years. Some aspects, like growth in connectivity demand or the convenience of landing traffic locally will generate faster developments in emerging markets. Yet, continuous deployments of large HTS systems continue to generate big opportunities in developed regions.



ST Engineering iDirect Market Share

Our ground infrastructure platform is designed to address the broad diversity of requirements and opportunities represented by HTS and DVB-S2X. The platform allows operators and providers to deliver the right throughput rate at the right cost, run large networks cost effectively, deploy new services rapidly — and continually stay ahead of the pace of technology.

The platform enables service providers to serve all segments and meet customer expectations such as raising bandwidth levels, expanding coverage areas and lowering both the cost of connectivity to end users as well as their own operating costs.

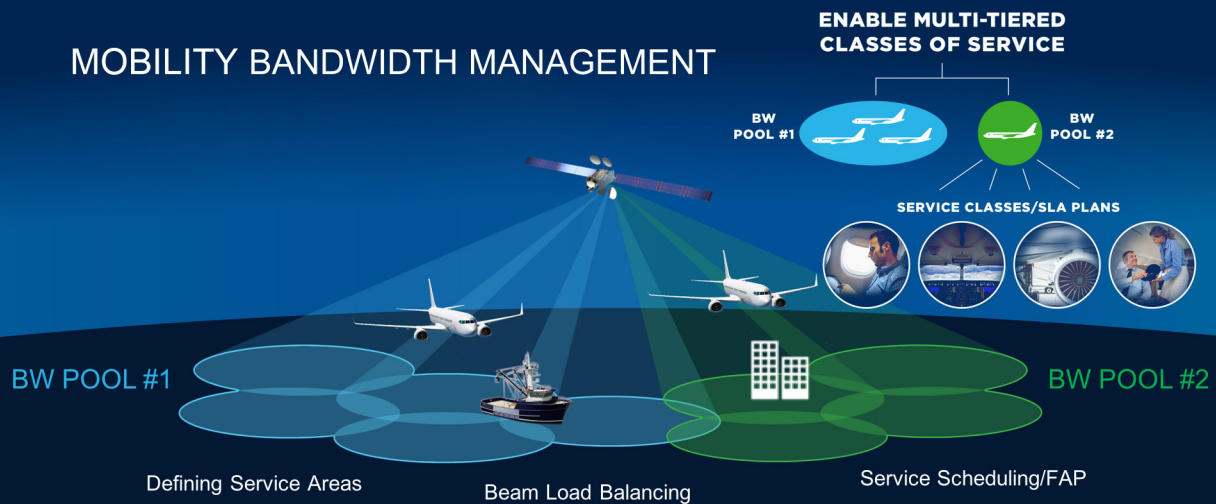
Key features of the platform are:

- **Flexible core architecture.** This allows an operator to manage an increasingly diverse and integrated network portfolio that comprises multiple satellites, frequency bands, market applications, and network technologies. It's also optimized for different forms of managed service offerings.
- **A modular design for scalability.** A hub chassis, which is designed to be populated with Universal Line Cards (ULCs) that can be upgraded with licensable features, enables HTS operators to increase throughput rates based on network demands.
- **Superior network management.** A comprehensive Network Management System to manage large-scale deployments, monitor network activity, drive profitability and integrate with third-party network management and operational support systems through open Application Protocol Interfaces (APIs).
- **Highest efficiencies and performance.** Our implementation of DVB-S2X enables higher MODCODs of up to 256APSK that support over 200 Mbps with L2oS and optimal carrier operations with 5 percent roll-off factors (ROF), which effectively lower the cost per bit of satellite capacity.
- **Cost-effective scale.** In iDirect hub technology we are using new virtualization schemes, cloud computing and higher processing capabilities to significantly increase the teleport density. Virtualizing key hub processing capabilities is the first step towards significantly reducing the gateway footprint.
- **A range of remotes for all market applications.** Our offering includes iQ Desktop, iQ 200 Series and the iQ LTE. The iQ Series supports DVB-S2/DVB-S2X and Adaptive TDMA featuring very high performance and efficiency designed to meet the needs of both fixed and mobility networks within a wide range of performance scenarios.
- **Automatic Beam Switching,** to connect an aircraft or vessel across satellite footprints without manual intervention.
- **Global Bandwidth Management,** which enables operators to manage a single bandwidth pool to ensure a customer's complex SLAs across a large coverage area spanning multiple spot beams. This includes load-balancing options for optimized spot-beam management in mobility networks.
- **Group Quality of Service** to manage the use of bandwidth across an entire mobility fleet, prioritizing service levels based on multiple criteria, including bandwidth profiles for individual aircraft or vessels, and specific applications.
- **Direct Sequence Spread Spectrum** to mitigate satellite interference common with ultra-small antennas or phased-array antennas, while maintaining a reliable and efficient link.
- **OpenAMIP®** an open-source IP based protocol that facilitates the exchange of information between the airborne antenna and the satellite router.
- **Advanced Security** to support critical information security risk management principles, such as those reflected in the ISO 27001 standard and the NIST Cybersecurity Framework.

MOBILITY : AUTOMATIC BEAM SWITCHING

- Fast reacquisition
- Make-before-break
- Skew angle mitigation
- Spread Spectrum

MOBILITY BANDWIDTH MANAGEMENT





Preparing for the Network of the Future

Satellite connectivity is undergoing a technology and business transformation, overcoming barriers of interoperability to become part of mainstream converged services and dramatically expand its role in the global communications landscape. And because HTS is transforming the economics of satellite service, operators can strongly position satellite as a viable part of the end-to-end network.

We believe the key to full mainstream adoption is for satellite networks to be defined by modern telecom standards and are developing proven network architectures that provide open programmable interfaces for end-to-end network orchestration and business system integration.

When it comes to scaling a satellite communications network, hub-side infrastructure is one of the largest capital expenses service providers face. We are continuously innovating to adopt virtualization and cloud computing practices to reduce the hub footprint, while vastly improving performance and scale.

With 5G on the horizon, we understand that satellite needs to seamlessly integrate with cellular and terrestrial infrastructure. Our goal is to provide the intelligence that enables all technologies working in unison across multi orbital satellite, terrestrial and mobile networks.

Further, we understand that the future requires multi-waveform capabilities that will enable a converged platform that combines capacity from all orbits, integrates with 5G cellular networks and supports subscriber roaming across service provider networks.

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